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CERTIFICATION

I, the below named translator, hereby declare that: my name and post office address are as stated below; that I am knowledgeable in the English and German languages, and that I believe that the attached text is a true and complete translation of PCT/EP2005/050286, filed with the European Patent Office on January 24, 2005.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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1 Description

2  
3 Force measuring device

4  
5 The invention relates to a force measuring device. The force  
6 measuring device has a housing manufactured as a single piece  
7 and made of metal, with upper and lower rigid housing parts,  
8 which can be moved in relation to each other in an elastic  
9 manner. A deflection sensor is attached between the two rigid  
10 housing parts, which can detect the deflection of the two  
11 rigid housing parts in relation to each other and forward it  
12 as an electrical signal.

13  
14 In the field of vehicle occupant protection, it has become  
15 increasingly important in recent years to tailor the release  
16 of occupant restraint means, for example front airbags, side  
17 airbags, knee airbags, curtain airbags, etc. to any vehicle  
18 occupants in the deployment zone of the occupant restraint  
19 means or even to suppress their release completely, in order  
20 on the one hand to avoid subsequent repair costs after  
21 unnecessary release, for example if a vehicle seat is  
22 unoccupied, and on the other hand not to put certain groups  
23 of people at further risk due to an inappropriate release  
24 response of the occupant restraint means, for example  
25 children or very small adults. It is therefore important not  
26 only to determine the presence of a person on a vehicle seat  
27 but also to determine classifying characteristics of the  
28 person, for example their body weight. Reference should be  
29 made in this context to the crash standard FMVSS208, with  
30 which vehicle manufacturers are increasingly required to  
31 comply and which requires a person to be classified by  
32 weight, so that in the event of a collision the activation of

1 an occupant restraint means can if necessary be tailored in  
2 the known manner to the identified person.

3  
4 It is known from the publication DE 100 04 484 A1 that force  
5 measuring devices can be disposed between the vehicle seat  
6 and the vehicle chassis to identify the weight of a person on  
7 a vehicle seat. The housing of the force measuring device can  
8 thereby be manufactured as a single piece and made of spring  
9 metal, with rigid housing parts (220) and (222) and spring  
10 means (232, 234), which connect the rigid housing parts (220,  
11 222) (Figure 4 and column 8, lines 18 to 27). A deflection  
12 sensor is disposed between the two rigid housing parts (220,  
13 222), for example an inductive deflection sensor (190, 192,  
14 194, 196, 198) (Figure 3), which can detect a deflection of  
15 the rigid housing parts (220, 222) and convert it to a  
16 measurement signal, which provides information about the  
17 force acting on the force measuring device.

18  
19 The published German patent application DE 101 45 370 A1  
20 discloses a similar force measuring device made of a single-  
21 piece metal housing (Figure 4b and column 6, paragraph  
22 [0059]) but with a different sensor principle.

23  
24 In order for them to be deployed usefully in a motor vehicle,  
25 the known force measuring devices have on the one hand to be  
26 manufactured such that they are very small, to take into  
27 account the limited space between a vehicle seat and the  
28 vehicle chassis and on the other hand they have to have an  
29 extremely high level of dimensional stability over the entire  
30 life of a vehicle, generally at least 15 years, in order to  
31 prevent the deflection sensor measuring in a systematically  
32 incorrect manner over the course of time where possible.  
33 However as far as the known force measuring devices are

1 concerned, these two requirements are conflicting and seem  
2 irreconcilable. To achieve a housing with permanent  
3 dimensional stability, which can withstand the very large  
4 weight loads of up to 1.2 t during operation of a motor  
5 vehicle, the housing of the force measuring device has to be  
6 extremely solid and quite large. The small space available  
7 however requires a filigree, small housing.

8  
9 The object of the present invention is to create a force  
10 measuring device with a housing with permanent dimensional  
11 stability and where possible without hysteresis, which is at  
12 the same time very small and simple to manufacture.

13  
14 The object is achieved by a force measuring device as claimed  
15 in claim 1.

16  
17 Advantageous embodiments are set out in the subclaims, with  
18 any expedient combination of features from the subclaims with  
19 the main claim coming within the scope of the patent.

20  
21 The inventive force measuring device comprises a single-piece  
22 housing made of metal. The housing comprises an upper rigid  
23 housing part and a lower rigid housing part, which are  
24 connected together by means of U-shaped spring elements and  
25 which can be moved in relation to each other in an elastic  
26 manner along a movement axis by the action of a force. The  
27 spring elements are disposed symmetrically to each other  
28 parallel to the movement axis in relation to a sectional  
29 plane. A deflection sensor is attached between the upper and  
30 lower rigid housing parts to detect the relative movement of  
31 the two rigid housing parts in relation to each other.

32 According to the invention the housing is manufactured using  
33 Metal Injection Molding (MIM) technology.

1  
2 The use of MIM technology has hitherto only been known from  
3 other technical fields, see for example a publication by the  
4 company Hans Schweiger GmbH, which could be found on March  
5 03, 2004 at <http://www.formapulvis.com/Index.htm>, in which  
6 the MIM production process is described for different areas  
7 of application.

8  
9 With MIM technology, also known as powder metal injection  
10 molding, a fine metal powder is mixed with primary binders  
11 and granulated, resulting in what is known as feedstock. The  
12 feedstock is melted in an injection molding machine and  
13 injected in a tool to form a molding. After cooling the  
14 components are removed as so-called "green" parts. The binder  
15 is then extracted from the green parts in a furnace. The  
16 binderless components are now called brown parts and are then  
17 sintered in a high-temperature furnace.

18  
19 MIM technology thereby combines the forming freedom of  
20 plastic injection molding with powder metallurgy. The MIM  
21 method therefore allows the production of highly integrated  
22 metal parts with complex geometries in large numbers with a  
23 high level of precision.

24  
25 The MIM method therefore makes it possible to produce housing  
26 walls of very precise thicknesses, thereby achieving very  
27 precisely calculated form and thickness characteristics in a  
28 metal housing of an inventive force measuring device. This  
29 allows a very small, elastic housing to be produced, such  
30 that a maximum internal stress of  $350 \text{ Newton/mm}^2$  is not  
31 exceeded at any point of the housing even at a required  
32 maximum nominal load of for example 150 kg on the force  
33 measuring device and at the same time a deflection of the

1 rigid housing parts in relation to each other of minimum 1  $\mu\text{m}$   
2 per kg of loading weight is achieved.

3  
4 The fact that the inventive housing is a single piece also  
5 means that hitherto complex joining processes between  
6 different components of the housing can be avoided, as a  
7 result of which hysteresis phenomena in the inventive force  
8 measuring device can be significantly reduced - due to the  
9 reduced number of joined edges.

10  
11 Advantageous embodiments of inventive devices are contained  
12 in the description of the figures below, in which:

13  
14 Figure 1 shows an exemplary embodiment of an inventive force  
15 measuring device (1) in cross-section,

16 Figure 2 shows a perspective view of the force measuring  
17 device according to Figure 1,

18 Figure 3 shows a top view of the force measuring device  
19 according to Figure 1 and

20 Figure 4 shows a cross-sectional view of the force measuring  
21 device according to Figure 1 along the sectional plane A-A.

22  
23 Figure 1 shows an advantageous development of an inventive  
24 force measuring device 1, comprising a single-piece housing  
25 2, manufactured using Metal Injection Molding (MIM)  
26 technology. The housing has an upper housing part 25 and a  
27 lower housing part 26, which are configured in a rigid manner  
28 compared with the U-shaped spring elements 21 and 22  
29 connecting the said two housing parts 25, 26, such that these  
30 two rigid housing parts 25 and 26 can move to and fro in  
31 relation to each other due to the action of a weight force  
32 but ideally without becoming deformed themselves. A  
33 deflection sensor 6 is attached between the two rigid housing

1 parts 25 and 26, which can detect a relative movement of the  
2 two housing parts 25, 26 in relation to each other and  
3 convert it to an electrical signal, which is routed via a  
4 cable connection (not shown) via a plug connector 5 to an  
5 electronic evaluation unit or is processed further in an  
6 electronic evaluation unit within the plug connector 5. This  
7 signal is fed to an occupant protection device (also not  
8 shown), where it is available as information about the weight  
9 acting on the force measuring device 1, as a result of which  
10 an occupant restraint means is released in an optionally  
11 tailored manner.

12  
13 For the purposes of the desirable low level of mechanical  
14 stress in the housing 22, as mentioned above, even subject to  
15 the action of a force, which is applied via a force induction  
16 means 3 by a vehicle seat to the upper rigid housing part 25  
17 and thus to the force measuring device 1, the arms of the two  
18 spring elements 22 and 21 form an acute angle  $\alpha$ .

19  
20 Also for the purposes of a largely regular stress  
21 distribution throughout the housing 2 of the force measuring  
22 device 1, each of the spring elements tapers from the upper  
23 rigid housing part 25 continuously until it achieves a  
24 minimum wall thickness  $d$  at the start of the bend to the U-  
25 curve. From this point the wall thickness increases again  
26 around the vertex of the U-curve, reduces again after the  
27 turn of the curve and remains constant until the point of  
28 transition to the lower rigid housing part 26. As the  
29 sectional plane AA represents a plane of symmetry of the  
30 spring element, the characteristic of the wall thickness  $d$   
31 along the spring element is the same as that of the spring  
32 element 22.

1  
2 The housing 1 shown also has a securing lug 4, in the form of  
3 two integral components behind each of the two curved springs  
4 21 and 22 shown respectively, with the aid of which the force  
5 measuring device 1 is connected by means of two screws 7 to  
6 the vehicle chassis. Other securing means, for example  
7 rivets, etc., could also be used instead of screws.

8  
9 Figure 2 shows a perspective view of the force measuring  
10 device in Figure 1. It can be seen that a further pair of U-  
11 shaped spring elements 24 and 25 is again disposed in a  
12 symmetrical manner around the two rigid housing parts 25 and  
13 26 behind the two securing means 4 with their associated  
14 screws 7. It can be seen particularly clearly in this diagram  
15 how, with the aid of the option of a very filigree  
16 configuration of the housing 2, the four curved springs 21,  
17 22, 23, 24 shown can be made as thin as possible, such that  
18 the securing points of the force measuring device 1 can be  
19 disposed within the same base area as is taken up by the  
20 entire housing 2 and the spring elements 21, 22, 23 and 24. A  
21 top view of this base area is also shown in Figure 4.

22  
23 Figure 4 shows a cross-section through the housing 2 of the  
24 force measuring device 1 along the line A-A in Figure 1. This  
25 cross-sectional diagram is intended to show the mode of  
26 action of additional overload protection elements 8, 9,  
27 already shown in the two figures 2 and 3 in a top view of the  
28 housing 2. The two overload protection elements 8, 9 are  
29 connected permanently to the upper rigid housing part 25, for  
30 example by means of a screwed connection. Toward the lower  
31 rigid housing part 26, the diameter of each of the two  
32 overload protection elements 8 and 9 gradually increases and



1 there is a roughly regular narrow air gap between it and the  
2 lower rigid housing part 26.

3  
4 In this manner the two overload protection elements 8 and 9  
5 move out of the housing 2 as soon as a force acts in the  
6 direction of the lower rigid housing part 26 via the force  
7 induction means 3. A further deflection of the two rigid  
8 housing parts 25 and 26 in relation to each other, if the  
9 action of the force increases further, is only prevented, if  
10 the two overload protection elements 8 and 9 have moved so  
11 far out of the housing 2 that they encounter a resistance due  
12 to the vehicle chassis. If a force acts in the reverse  
13 direction, deflection of the two rigid housing parts 25 and  
14 26 in relation to each other occurs until the gap between the  
15 lower rigid housing part 26 and the graduation in each of the  
16 two overload protection elements is closed.